

# **REAL-TIME PLUTONIUM, AMERICIUM, AND CURIUM MONITOR**

## **TECHNOLOGY DESCRIPTION**

This project is developing an on-line monitor that can measure in real time the concentrations of various metal oxides in a molten-glass stream. It can be used to measure most transuranics in a vitrification process stream. The monitor uses the spontaneous thermal emission spectrum of the molten-glass stream to measure the stream composition. It passively observes this spectrum through a fiber-optic cable, so the instrument can be mounted outside the radiation zone. It uses a charged-coupled-device (CCD)-array-based spectrometer mounted on a personal computer expansion card, so the instrument as a whole is small and robust. The emission spectrum contains certain peaks that are characteristic of the individual transuranic metal oxides and whose heights indicate the concentrations of the metals. The baseline technology for vitrification monitoring requires sampling the glass, transporting the highly radioactive glass to the laboratory, performing a destructive analysis, most commonly using inductively coupled plasma (ICP) techniques, and then storing or disposing of the sample. The project technology is safer, faster, and cheaper because it provides an analysis in real time without contacting the glass stream.

## **TECHNOLOGY NEED**

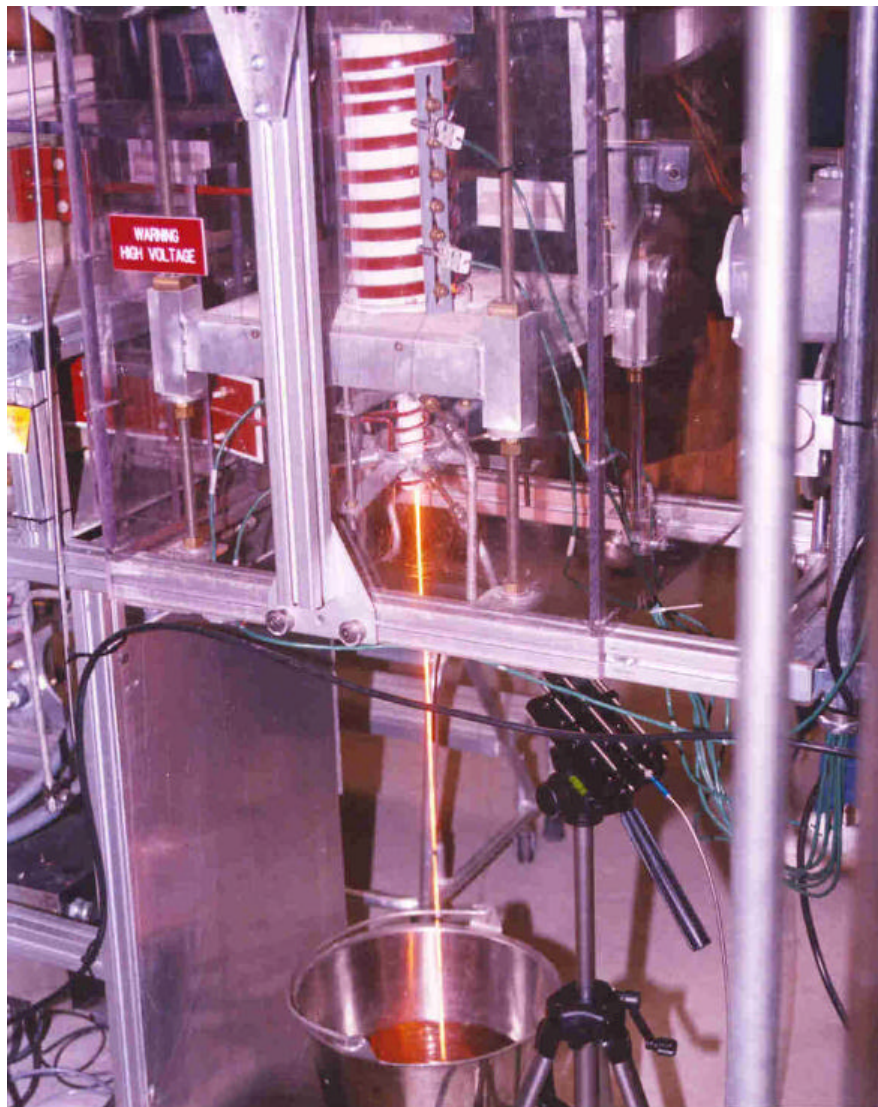
When the U.S. Department of Energy (DOE) uses vitrification, it is usually for processing wastes containing radionuclides whose presence must be quantitatively tracked. The infrared monitor can measure the amount of most transuranic metals, as well as many other metals, in a molten-glass stream, so the monitor is potentially useful for most DOE vitrification processes. Work is being conducted with the Americium-Curium Stabilization Project at the Savannah River Site (SRS), so the device is being tailored to measure americium and curium to satisfy their Site Technology Coordination Group (STCG) Need SR99-5003 entitled "Non-Destructive Assay (NDA) of Vitrified Americium/Curium." A monitor will be delivered to them at the end of FY 1999, and it will be incorporated into the F Canyon vitrification system set to go on-line in 2002.

## **TECHNOLOGY BENEFITS**

The on-line monitor provides both cost and safety benefits while improving control of the vitrification process. It reduces the number of samples that must be taken and analyzed off line, thereby improving worker safety by reducing the handling of highly radioactive materials. Each sampling and off-line analysis is estimated to cost between \$50 and \$100 K, will require about one week, and will generate secondary waste. Once installed and calibrated, the on-line monitor will provide analyses automatically at a negligible cost in less than one minute without contacting the radioactive material. The immediate information feedback provided by the monitor will alert the vitrification operators to problems or unexpected conditions so that they can be efficiently handled. The monitor record would also provide a more detailed archival record of the composition of the vitrified material than occasional sampling and analysis can.

## **TECHNOLOGY CAPABILITIES/LIMITATIONS**

The thermal emission spectrometer can use near-infrared spectroscopy to monitor in real time the concentrations of transuranics and many other metal oxides in molten-glass streams or static pools up to about one-quarter inch thick. The technology is potentially applicable to most vitrification processes. A light-gathering head within about 2 feet of the glass is connected by a fiber-optic cable to the rest of the instrument, so the monitor is largely unaffected by the radiation level of the glass. The monitor does depend on the transparency and high temperature of the molten-glass, so it can not be used on thick (opaque) glass or on lower temperature (roughly under 1000° C) glass.



The tripod-mounted, light-collection head of the monitor can be seen in the lower right portion of this photograph taken during a 1998 test of the monitor at the Savannah River Site (SRS). The rest of the monitor is many feet away, connected by a fiber-optic cable. The head is aimed up at the beginning of the glowing molten-glass stream that is pouring from the Cylindrical Induction Melter into a pail of water.

## **COLLABORATION/TECHNOLOGY TRANSFER**

Through collaboration with the staff of the Americium-Curium Stabilization Project at Savannah River, the monitor technology and protocol are being tailored to their needs. Start up of vitrification in their canyon facility is scheduled for 2002, and the on-line monitor will be part of that facility. They are hosting on-site tests of the monitor on their developmental vitrification melter, as well as supplying test materials. A functional

monitor system will be delivered to them at the end of FY 1999; delivery of the system will be followed by work on training, operation, safety and regulatory matters. Thermal emission spectroscopy is a mature technology and its application to vitrification is a niche market; therefore, no efforts toward commercialization have been made. A paper on the project results was given at Pittcon, the principal analytical science conference in North America, in March 1998.

## **ACCOMPLISHMENTS AND ONGOING WORK**

So far, two on-site tests of the on-line monitor have been conducted at Savannah River. The first test was in August 1997 which was conducted with the staff of the Glass Formulation and Vitrification Process Development Task for the Plutonium Immobilization Program. The second test was in July 1998 which was conducted with the staff of the Americium-Curium Stabilization Project. The first of these tests compared thermal emission spectroscopy (TES) and a variant of TES called transient infrared spectroscopy as monitoring methods. TES was found to be superior. The second test applied an improved monitor to a melter system that was much closer to what will be used for actual vitrification at Savannah River. Both tests showed successful quantitation of surrogates for transuranics in the molten-glass. Later in FY 1999 another site test with the Americium-Curium Stabilization Project will be held to test the newest version of the monitor and an internal-spike method for improving the accuracy of the measurements. Parallel with these tests has been work to convert the original laboratory-style device to a field unit. The original monitor had an instrument box located very near the glass stream and required three supporting boxes of electronics along with a personal computer to control it all. This has now been condensed to a small light-collection head within a foot or two of the stream that connects via a fiber-optic cable to an expansion board inside a personal computer. The remaining electronics were eliminated. A complete monitor system will be delivered to Savannah River by the end of FY 1999 so that the staff may begin working with it and start incorporating it into the vitrification process system, which goes on-line in 2002.

## **TECHNICAL TASK PLAN (TTP) INFORMATION**

TTP No. CH17C232 - "Real-Time Plutonium Monitor (also for Americium and Curium)." The previous title for this TTP was "Real-Time Plutonium Monitoring by Transient Infrared Spectroscopy."

## **CONTACTS**

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